REMEDIATION OF WATER CONTAINING PERCHLORATE USING BIOLOGICAL AND ION EXCHANCE TECHNOLOGIES

Edward N. Coppola
Applied Research Associates, Inc.
Gulf Coast Division
215 Harrison Avenue
Panama City, FL 32401
Phone: (850) 914-3188, Email: ecoppola@ara.com

William J. Guarini
Envirogen, Inc.
4100 Quakerbridge Road
Lawrenceville, NJ 08648
Phone: (609) 936-9300, Email: guarini@envirogen.com

This presentation will briefly highlight the currently recognized biological and ion exchange technologies for perchlorate. Perchlorate has been identified as a water contaminant in at least 22 states, including California, Nevada, New Mexico, Arizona, Utah, Massachusetts and Texas. Current estimates suggest that the compound may affect the drinking water of as many as 17 million people. The history of exposure guidance for perchlorate, proposed by the EPA, is summarized in Table 1. This guidance has been the impetus behind recent perchlorate remediation concerns.

Table 1. Perchlorate Exposure Guidance

Draft Guidance:	EPA 1992	EPA 1995	EPA 1998	EPA 2002	OEHHA 2002
NOAEL/LOAEL, mg/kg/day	0.14	0.14	0.1	0.01	0.01
Uncertainty Factor	1000	300-1000	100	300	30
RfD, mg/kg/day	0.0001	0.0001-0.0005	0.0009	0.00003	0.0003
Corresponding drinking Water Concentration, mg/L					
Adult (70kg & 2L/day)	4	4-18	32	1	6
Child (10kg & 1L/day)	1	1-5	10	0.3	2

Biological treatment represents a proven technology for the effective and economical removal of perchlorate from water. This paper presents full-scale applications and field demonstrations of biological technology for direct treatment of ground water that includes the following:

- Case Histories for the three full scale ex situ biological systems using a Fluidized Bed Reactor will be presented including the Aerojet system, Longhorn Army Ammunition Plant system and an abbreviated description of a Navy installation;
- A description of a second, successfully piloted reactor design, the fixed bed reactor, will be presented;
- A description of range of concentrations and contaminants treatable, based on pilot studies, in the fluidized bed reactor;
- A case history for a full scale in situ system at the McGregor Naval Weapons Industrial Reserve Plant will be presented;

- An overview of field pilot in situ projects; and
- Finally, mention of some other promising technologies such as phytoremediation.

Several ion exchange systems have also been installed for groundwater remediation and drinking water treatment. Full-scale systems that will be briefly discussed include Calgon Carbon's ISEP processes in the San Gabriel Basin in Southern California and in Nevada, and traditional ion exchange processes using non-regenerable resins in conventional "lead-lag" ion exchange equipment. Ion exchange pilot tests have been conducted, or are planned, to demonstrate the performance of new, perchlorate-selective ion exchange resins. Tests were recently conducted at Edwards Air Force Base and an ESTCP project is planned for Massachusetts Military Reservation (MMR). The MMR project will use a small pilot system to demonstrate multiple resin regenerations; spent regenerant treatment and reuse technologies; and a low-cost perchlorate field monitor capable of perchlorate detection to below one part-per-billion.

Ion exchange is not a destruction process. Except for non-regenerable systems, where the resin is incinerated once it is exhausted, spent regeneration solutions are generated that contain significantly elevated concentrations of perchlorate and nitrate. Perchlorate and nitrate in spent regenerating solutions can be catalytically reduced, biologically reduced, or thermally destroyed. Biodegradation of ion exchange brine has been successfully employed at the ATK-Thiokol facility near Brigham City, Utah since 1997. This plant was recently modified to increase capacity and enable the treatment of up to three different effluents simultaneously – ammonium perchlorate, sodium and potassium perchlorate brine, and high nitrate waste streams. Treated water is ultimately discharged under a NPDES permit. A similar system is currently being constructed to treat effluent from a gunpowder manufacturing facility near Herrington, Kansas.

A pilot biodegradation demonstration is planned for this year for the La Puente Valley County Water District in Southern California. This demonstration, which is sponsored by the EPA and American Waterworks Research Foundation (AWWARF), will treat spent ion exchange brine currently being generated by the Calgon Carbon ISEP ion exchange process. The field-demonstration unit will be a trailer-mounted system.

A summary of different perchlorate treatment technologies is presented in Table 2. This table provides the ranges of demonstrated or acceptable perchlorate concentrations and TDS (total dissolved solids) for the major technologies presented in this paper.

Process	Supplier	Capability								Application or Water Type	Maturity or Scale
		TDS, %				ClO_4^-, mg/L					
		0.1	0.5	1	4	<1	10	10^2	10^3		
Bio - CSTR Suspended	ARA									W/W, G/W IX Residuals	Dec 1997 FS - Com.
Bio - FBR Fixed-Film	Envirogen/ US Filter									Ground & Drinking?	1999 FS – Com.
Ion Exchange Non-regen.	Calgon Carbon Corp									Ground & Surface	1999 FS – Com.
Ion Exchange ISEP	Calgon Carbon Corp									Ground & Drinking	Mar 2001 FS – Com.
Ion exchange A-530E Resin	Purolite									Ground & Drinking	Demos Com. Resin

Table 2. Technology Capability Summary